

Innovative Design of Combined Stationery Products Based on KANO Model and TRIZ Theory

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Abstract: In response to the short life cycle, serious waste of resources, and cumbersome steps in the product use process in the stationery market, from the perspective of sustainability and ergonomics, comprehensively apply the KANO model and TRIZ theory to study the improved design of stationery sets. Taking the target user as the interview object, firstly conduct user interviews and discover the pain points of the existing stationery sets on the market; propose improved demand points for the concentrated pain points, and conduct KANO questionnaire distribution and analysis to obtain the key requirements for improving user satisfaction; combine the key requirements, Using the 39-factor Altshuller contradiction matrix table provided by TRIZ theory and 40 invention principles, through comparison and screening, the final optimized design plan is obtained, which provides solutions for the improved design of stationery sets, so as to improve the product and the user, The relationship with the use environment, to achieve the purpose of product sustainability.

Keywords: Combination stationery, KANO model, TRIZ theory, Sustainable design

1. Introduction

With the economic development, the sustainable development strategy has been incorporated into the long-term planning of China's economic and social development. In the stationery market with huge consumption, it also pays great attention to sustainable product design, such as the application of environmental protection materials and product recycling, which all reflect the contribution of the stationery industry in the sustainable development of (Fang & Yang, 2020). As the most common product in the stationery market, the stationery suit has a short life cycle, which is easy to cause a waste of resources. Therefore, under the concept of sustainable design, it is of social value to conduct an in-depth analysis of the human-machine environment system by considering the design of the whole life cycle of products, gain insight into the market trend, tap the consumer demand, and carry out the innovative design of combined stationery.

2. KANO-TRIZ model

The KANO model, proposed by Noriaki Kano, a professor at Tokyo University of Technology, is used as an analytical model to reflect the relationship between service quality and satisfaction, and is widely used in user demand analysis and acquisition.(KANO&Et.Al,1984) TRIZ theory is "invention problem solving theory", is the former Soviet inventor Altshuller led by TRIZ research team through collection, sorting, research a large number of patents, literature, and induction, refining a set of system to solve the problem of invention, can creatively find and solve problems to provide effective theory and method tools.(Altshuller, 1999)(Liu & Li, 2020)

Xiong Yunjia uses Kano model and the four-quadrant model to accurately identify the human-computer interface design requirements of business intelligence systems to meet user expectations in agile development scenarios, providing a useful reference method for its interface design(Liu&Li,2020); Cui Chongyao investigated, classified and studied the existing children's furniture, and summarized the common principles of the 40 invention principles in the TRIZ theory commonly used in children's furniture(Cui et al.,2017); Yang Jing established the KANO-TRIZ model, and used it to innovate the product design, basically realizing the transformation from demand acquisition to demand(Yang, 2017); Deng Zhao et al. used the KANO model to analyze the problems encountered by helmet users during riding, conducted a weighted average analysis of user needs combined with QFD, and used the innovative invention principles of TRIZ to analyze key needs and improve the problems of the helmet, and improve their safety (Zhao&Chen, 2021);Long-Sheng Chen et al proposed the TRIZ technology integration into the TRIZ-Kano model in the traditional Kano model, evaluating the effectiveness of this model according to the real case of the online game quality survey (Chen et al., 2008).

This research uses KANO model and TRIZ theory, uses KANO model to explore and insight into user needs, and uses TRIZ theory to quickly find the design method, providing solutions for the rapid and effective realization of innovative design of combined stationery.

3. Stationery Set needs analysis

3.1 Stationery set status

At present, most of the existing stationery sets on the market exist in the form of Figure 1, wrapped in rubber pen bag or plastic box, containing pen, ruler, protractor, compass and other components.The main target population of the product is primary and middle school students; to some extent, the existence of combination tape sleeve improves the learning efficiency of the key problems of primary and middle school students in science and engineering courses.However, the shortcomings of the combination of measures can not be ignored, including too many components, resulting in the loss of irregular placement in use, or the frequent occurrence of all components because of borrowing and other factors, often resulting in the waste of resources.

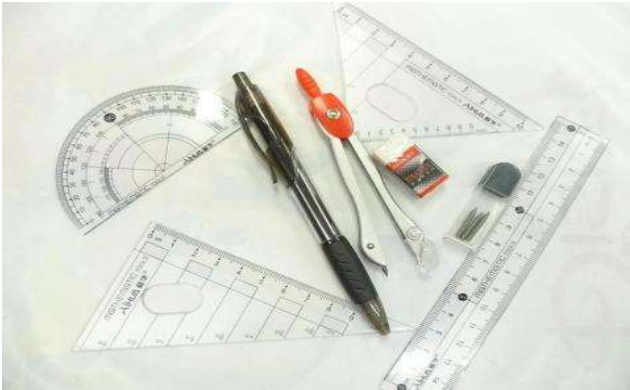


Figure 1 Stationery set on the market

3.2 Stationery set pain point analysis

In view of the above questions, we randomly interviewed 6 primary and middle school students, including 3 boys and 3 girls, near primary school, junior middle school and senior high school. The interview time was 10min each. The interviews summarized the pain points in Table 1.

Table 1 User Interview Table

Serial Number	Age	Frequency With Which Stationery Kit Components Are Used	Consider The Disadvantages Of Stationery Components	Consider The Advantages Of Stationery Components	Whether You Are Willing To Buy Combination Stationery
1	10	Overall lower, pens and rulers are used more frequently	(1) Too many things, easy to lose (2) Some components are not used	Easy to use	Neutral
2	11	Moderate frequency	(1) The scale disappears quickly due to the high frequency of using the straightedge (2) The round gauge is too heavy	Easy to use	Willingness
3	14	High frequency of use	(1) Too many components, often can not find, easy to lose (2) The case does not fit into the pen bag and occupies a large area	Targeted portability of target components Complete functionality	Willingness
4	14	High frequency of use	Not portable	Complete functionality	Willingness
5	16	High frequency of use	Trouble with recycling	Complete functionality	Willingness
6	17	Moderate frequency of use	Too frequent replacement of components during use	Complete functionality	Willingness

According to the interview results, it can be summarized as three main pain points: (1) Too many components, easy to lose.(2) Uneasy to carry.(3) The use process experience is poor, and the recycling and sorting out is troublesome.

3.3 Analysis of the combined stationery requirements based on the KANO Model

The Kano model divides the user needs into three levels: basic needs, expected needs, and exciting needs.As shown in Figure 2,the abscissa represents the realization degree of user demand, the vertical coordinate represents the user satisfaction, and the three curves from top to bottom respectively represent the relationship between the satisfaction of charm demand, expected demand and basic demand and user satisfaction respectively.(Noriaki Kano, 1984)

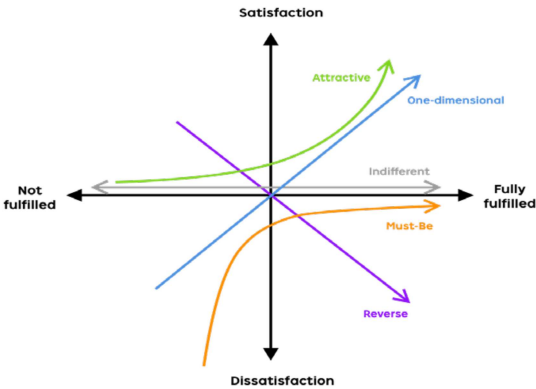


Figure 2 Schematic diagram of KANO model

3.3.1 KANO questionnaire

According to the pain points obtained by the user interviews, the corresponding solution function is proposed.When designing the questionnaire, we set the positive and negative directions from both angles: the demand index can be met and cannot be met.The respondents chose one of them: "I am happy", "It should be", "I don't care", "I can tolerable" and "I hate it" on two positive and negative questions. The questionnaire was designed as shown in Figure 3.

4. All-in-one design

	I am very happy	It should be	I don't care	I can tolerate	I hate it
How would you feel if the round rule set stationery was integrated into one product?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How would you feel if the round gauge set ruler text remained a separate component	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Figure 3 KANO questionnaire design

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3.3.2 Demand classification

User requirements are sorted and summarized according to the KANO model requirements classification table, which is shown in Table 2.

Table 2 Demand Classification

Product Requirements		Negative Issues				I Hate It
		I'm Very Happy	As It Should Be	I Don't Care	I Can Tolerate	
Positive Questions	I'm Very Happy	Q	A	A	A	O
	It Should Be	R	I	I	I	M
	I Don't Care	R	I	I	I	M
	I Can Tolerate	R	I	I	I	M
	I Hate It	R	R	R	R	Q

*A represents charm demand, M represents basic demand, O represents one-dimensional demand, I represents irrelevant demand, R represents reverse demand, and Q represents problem demand.

A total of 56 questionnaires and 53 valid questionnaires were issued. The questionnaire sets 8 demand indicators from three aspects of function, structure and material. Statistical results of the questionnaire are presented in Table 3. Use Formula (1) and (2) to calculate the satisfaction coefficient Si and the dissatisfaction coefficient Di respectively to obtain the KANO attribute of each demand index.

Si=(XA+XO)/(XA+XO+XM+XI) (1)

Di=(XO+XM)/(XA+XO+XM+XI) (2)

XA indicates the frequency of charm demand index, XM indicates the frequency of basic demand index, XO indicates the frequency of one-dimensional demand index, and XI indicates the frequency of irrelevant demand index.

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Table 3 Questionnaire Statistical Results Table

User Requirements	Quality Serial Number					Total	Satisfaction Factor Si	Dissatisfaction Factor Di	Kano Properties
	A	O	M	I	R				
1.Integrated Design	22	12	10	7	2	53	0.67	0.43	A
2.Easy To Carry	20	13	9	9	3	53	0.62	0.54	O
3.Straightedge Cleaning	6	29	4	12	2	53	0.69	0.65	O
4.Round Gauge Safety	10	23	8	10	3	53	0.60	0.58	O
5.Protractor Minimization	16	5	14	16	6	53	0.47	0.57	M
6.Pen And Circle Gauge Integration	24	11	9	7	5	53	0.60	0.52	A
7.Pen Removable	17	5	19	10	2	53	0.45	0.55	M
8.Moderate Material Weight	22	13	11	5	2	53	0.69	0.47	A

According to the calculation results in Table 3, construct scatter plots with satisfaction and dissatisfaction coefficient as vertical and abscissa, respectively, with the mean of Si and Di as the critical line, and divided into four quadrants of Kano model, see Figure 4. The first quadrant belongs to the desired demand, including "easy carrying, ruler cleaning, compass safety" to improve user satisfaction; the second quadrant is exciting, including "integrated design, pen and compass integration, moderate material weight", can enhance product charm; the third quadrant is irrelevant, and the fourth quadrant is basic demand, including "protractor minimization and pen removable". Among them, once the user needs of the first and second quadrant are met, the product user satisfaction can be improved. Therefore, the six user needs of "easy to carry, ruler cleaning, compass safety, integrated design, pen and compass integration, and moderate material weight" are taken as the important user needs of combined stationery.

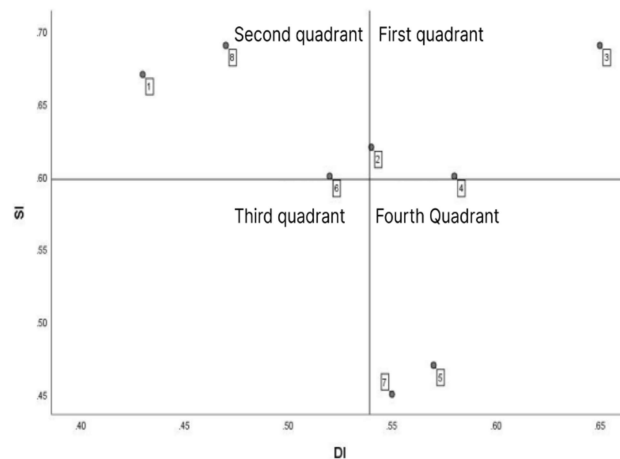


Figure 4 User design four-quadrant diagram

3.4 Improvement design of stationery set based on TRIZ theory

TRIZ is exactly the same as traditional human problem-solving methods, but TRIZ is more efficient and comprehensive than traditional problem-solving methods. The methods that TRIZ uses to solve innovation problems include: 39 engineering parameters, technical contradiction matrix, 40 invention principles, standard solution of invention problems and standard algorithm of invention problems. (Altshuller, 1999) This study will take the technical contradiction matrix and 40 invention principles as the main research tools.

Based on the six important requirements determined by KANO model, "easy to carry, ruler cleaning, compass safety, integrated design, pen and compass integration, moderate material weight", the technical contradiction matrix query:

2 "Easy to carry" demand function is mainly realized by improving the volume of product and product function, that is, the parameter intended to improve in the corresponding technical contradiction matrix is "8 volume of static objects", and the parameter leading to deterioration is "12 shape", that is, the corresponding invention principle is "7,2,35";

3 "Straight ruler cleaning function" is mainly realized by changing the shape of the original ruler, that is, the parameter to improve in the corresponding contradiction matrix is "12 shape", and the deterioration is "8 volume of static objects", that is, the corresponding invention principle is "7,2,35";

4 "Compass safety" is mainly realized by changing the functional structure of the compass, that is, adding components, that is, the parameter wanting to improve in the corresponding technical contradiction matrix is "12 shape", and the parameter leading to deterioration is "the stability of 13 structure", that is, the corresponding invention principle is "33,1,18,14";

1 "Integrated design" is mainly realized through the integration of functions, that is, the parameter intended to be improved in the corresponding technical contradiction matrix is "8 volume of static objects", and the parameter leading to deterioration is "12 shape", that is, the corresponding invention principle is "7,2,35";

6 "Pen and compass integration function" is mainly realized by changing the volume of the

product, that is, the parameter intended to improve in the corresponding technical contradiction matrix is "8 volume of static objects", and the parameter leading to deterioration is "12 shape", that is, the corresponding invention principle is "7,2,35";

8 "Moderate material weight" is mainly achieved by changing the weight and material of the product, that is, the parameter wanted to improve in the corresponding technical contradiction matrix is "2 weight of static objects", and the deterioration parameter is "8 volume of static objects", that is, the corresponding invention principle is "35,5,2,14";

Table 4 Application Frequency Of Invention Principle

Principle Of Invention	7	2	35	5	14	1	18	33
	Nested Principle	Extraction Principle	Principle Of Changing Physical Or Chemical Parameters	Combination Principle	Surfaceization Principle	Principle Of Segmentation	Mechanical Vibration Principle	Homogeneity Principle
Number Of Occurrences	4	5	5	1	2	1	1	1

According to Table 4, the three invention principles of "35 principles of changing physical or chemical parameters", "7 nested principles" and "2 extraction principle" appear more frequently, so the three invention principles are mainly used as the main design principles.

4. Stationery Set improved design practice

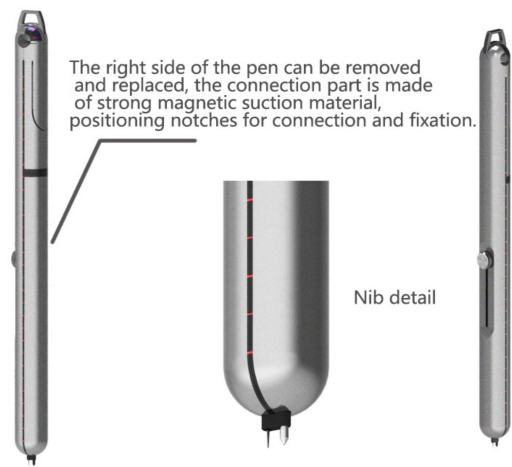


Figure 5 Design overall diagram

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In the specific design, the product structure of stationery set is first analyzed. Ordinary stationery set mainly includes basic components such as ruler, ruler, compass, protractor, pen, rubber and other components. Based on the principle of easy integration of product functions, four basic functional components of ruler, compass, protractor and pen are selected for product combination design. In these four components, we rank the pen, ruler, compass and protractor according to the frequency of use, obtained by user interviews. From the network research report, middle school students must bring pen every day, so we will "pen" as the main function of combined stationery, ruler, compass and protractor as ancillary functions. The product shape is developed in the basic form of the pen. The traditional pen holder is divided into two separate parts. One part is used to place the pen and the other part is used to place the compass needle to meet the basic components of the compass. After equal division, the two pen holders 180° are expanded, and the inner plane is used to present the scale of the ruler; the top connecting ball is used as a scale display of the protractor, which is rotated through the side of the cylinder; the other side of the cylinder can be used to replace the different types of pens required. Through the integration of functions we will integrate four separate components into a separate form of "pen", largely solve the problem of "inconvenient", reduce the cost of the stationery package, shorten the product design cycle, simplify the use of finishing stationery and other steps in the later period, realize the sustainability of products.

Specific design practices are obtained based on the combination of the TRIZ technical contradiction matrix and the invention principle, as shown in Figure 6,7,8,9,10.

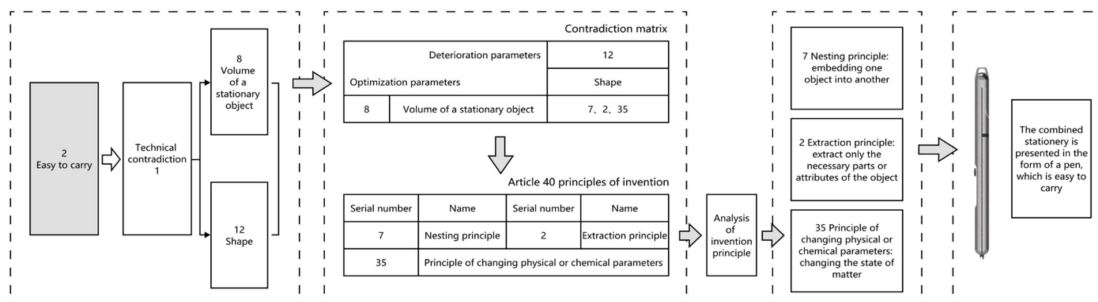


Figure 6 "2 Easy to carry" function conversion

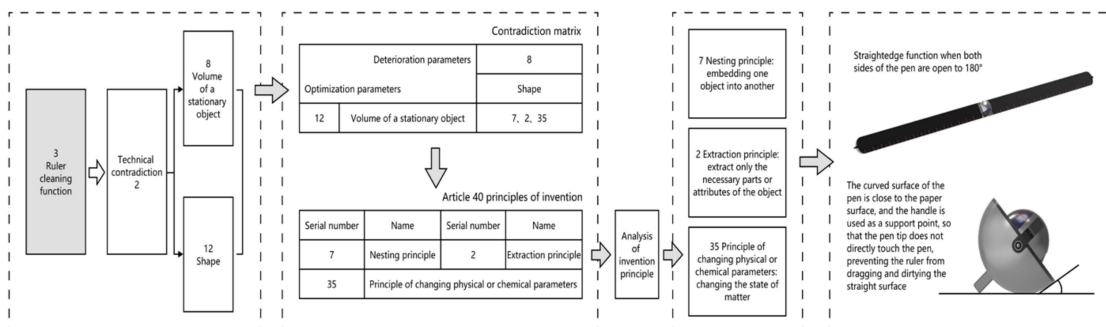


Figure 7 "3 ruler plot function" function conversion

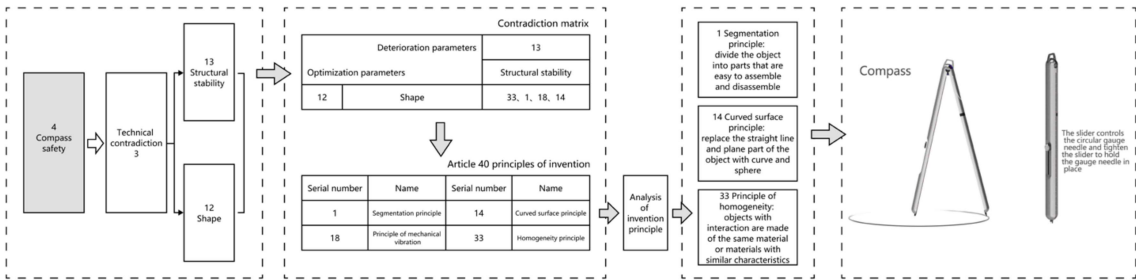


Figure 8 "4 Compass Security" function conversion



Figure 9 "1 Integrated Design" function conversion

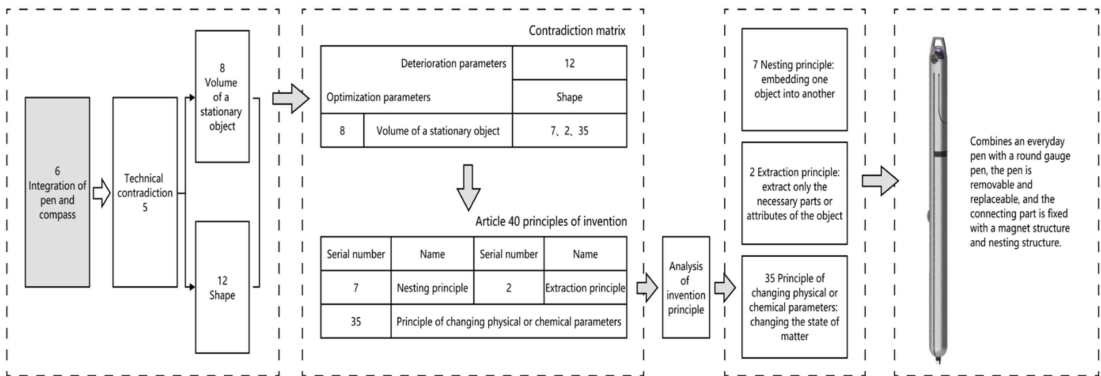


Figure 10 "6 pens and compasses integration" function conversion

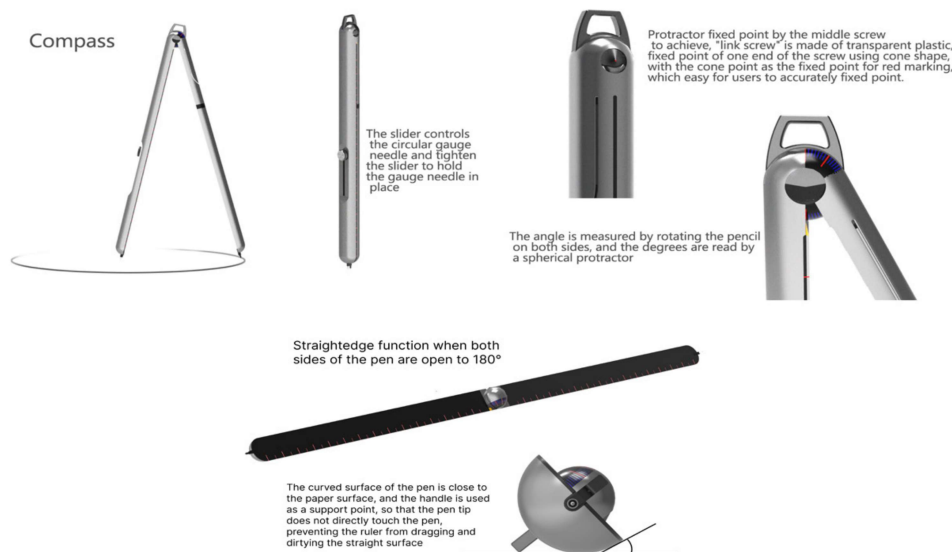


Figure 11 Details

5 Conclusion

In this research, taking the innovative design of stationery set as an example, the KANO model is used to obtain user needs, and conduct analysis and screening, with the charm needs and expected needs as the key needs to improve user satisfaction, combined with the technical contradiction matrix of TRIZ theory to obtain the corresponding invention principle, and finally, the innovative design scheme is optimized. This research concentrates on the advantages of KANO model and TRIZ theory to realize the innovative design and sustainable design of stationery sets.

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